South Carolina
Economy - Energy - Environment

# WASTEWATER TREATMENT ENERGY CONSERVATION REPORT – SAMPLE RECOMMENDATION

## INTRODUCE PERACETIC ACID BEFORE ULTRAVIOLET TREATMENT

**Recommended Action**

Install a peracetic acid (PAA) feeder system ahead of the ultraviolet (UV) disinfection lamps. Add a low dose of PAA (e.g. 1 part per million [ppm]) and reduce illumination of the UV lamps.

**Background**

Peracetic acid (PAA) is a disinfectant that is gaining traction in the wastewater treatment industry for its ability to remove pathogens at a cost that is competitive with other alternatives (e.g. chlorine, UV, and ozone). PAA is produced by combining acetic acid with hydrogen peroxide with the final chemical application to wastewater usually being a mixture of 15% PAA and 23% hydrogen peroxide. This combination has a stronger oxidizing potential than hydrogen peroxide alone and thus the dose required for disinfection is reduced. When discussing PAA below, the mixture of 15% PAA and 23% hydrogen peroxide is assumed.

PAA has shown beneficial effects when combined with UV disinfection. Photons of UV light interact with PAA molecules to create free radicals that greatly enhance the kinetics of pathogen inactivation. PAA added ahead of UV light banks has the added benefit of helping keep the UV light banks clean and thus reducing maintenance costs and downtime associated with cleaning the bulbs.

There are a few reasons that might motivate wastewater treatment plant staff to install PAA in combination with their existing UV disinfection. A key driver in some recent applications is meeting regulatory permit limits for pathogens. Some systems have seen violations with pathogen reduction, especially during wet-weather events. PAA helps improve disinfection and thus reduced those violations. Another driver is plant expansion that would increase the wastewater flow above the design flow of the UV system. PAA addition can make the achievable flow increase, thus mitigating the need to install a new, capital-intensive UV train. A third driver is flexibility; if the UV system needs to be taken offline or the number of bulbs reduced, (such as when bulbs or banks burn out) peracetic acid can be a backup disinfection measure. A fourth driver is energy reduction. The feasibility of reducing energy depends on the nature of the UV system. The system needs to be one where the bulb illumination intensity can be reduced. Not all UV systems are designed for this turndown capability, but if the UV bulb intensity can be reduced then a low dose of PAA ahead of the bulbs can allow the UV to operate at lower intensity and thus lower energy. The cost of PAA addition may be lower than the cost of electrical energy saved.

**Anticipated Savings**

The anticipated savings depend on the energy currently being used for UV disinfection at the plant. A typical power consumption for treatment of wastewater by UV is 4 kW/MGD. One of the plants visitied treats about 13 MGD of wastewater. The annual energy use for UV is then

$$4\ \frac{kW}{MGD} \times 13\ MGD\ \times 8760\ \frac{hours}{year}\ =\ 455{,}520\ \frac{kWh}{year}$$

At an electricity price of 0.043 \$/kWh, the annual energy cost for UV disinfection is estimated to be \$19,587 per year.

Most UV lamps that have the capability to be turned down to reduce electricity consumption can go as low as 60% power (which is a 40% reduction in electricity). It was stated during the site visit that at the plant the maximum turndown is better, 40% (for a 60% reduction in electricity). PAA can likely be added at a dose that will allow this level of turndown. The estimated annual *electric consumption savings (ECS)* that results from this turndown is

$$ECS = 455{,}520\ \frac{kWh}{year} \times 0.60$$

$$\boldsymbol{ECS = 273,312\ \frac{kWh}{year}}$$

At an electricity consumption rate (CR) of 0.043 \$/kWh, the estimated annual *electrical consumption cost savings* (*ECCS*) would be

$$ECCS = ECS\ \times CR$$

$$ECCS =\ 273{,}312\ \frac{kWh}{year} \times 0.043\ \frac{\$}{kWh}$$

$$\boldsymbol{ECCS = \$11,752\ /year}$$

Turning down the UV bulbs would also result in a reduction in energy demand. The *electric demand savings* (*EDS*) is the anticipated demand (*AD*) subtracted from the current demand (*CD*):

$$CD = 4\ \frac{kW}{MGD} \times 13\ MGD = 52\ kW$$

$$AD = 52\ kW * 0.4 = 20.8\ kW$$

$$EDS = CD - AD$$

$$EDS = 52\ kW - 20.8\ kW$$

$$\boldsymbol{EDS = 31.2\ kW/month}$$

The electric demand cost savings (EDCS) is the EDS multiplied by the demand charge, multiplied by twelve months to sum the total savings for the year.

$$EDCS = EDS \times EDC\ \times 12\ months\ per\ year$$

$$EDCS = 31.2\ \frac{kW}{month} \times 11.16 \frac{\$}{\frac{kW}{month}} \times 12 \frac{months}{year}$$

$$\boldsymbol{EDCS = \$4,178/year}$$

The *total energy cost savings (TECS)* for using PAA would be

$$Total\ Energy\ Cost\ Savings = \ ECS + EDS = \$11{,}752 + \$4{,}178$$

$$\boldsymbol{Total\ Energy\ Cost\ Savings = \$15,930}$$

## Implementation Cost/Simple Payback Period

The *capital implementation cost* for installation of the plumbing and hardware to feed PAA would be on the order of $10,000. A vendor reported that the annual cost for purchasing deliveries of PAA would be on the order of $90,000, assuming a dose of 0.5 mg/L PAA, 13 MGD wastewater flow, and $0.70 per pound of 15% pure PAA. This means there would be no payback with PAA implementation; the annual cost exceeds the annual energy cost savings.

Another key confounding factor is that the UV lamps may already be operating at a low turndown. On the day of the assessment they were operating at 100%, but the operators stated this was a unique day. Further, implementation of PAA might require an initial study, including laboratory analysis, which could cost several tens of thousands of dollars. The overall recommendation, then, is to not implent PAA dosing at this time. However, this section is included in the report so that if costs or assumptions change, this can serve as a helpful template to perform new calculations.

The plant may consider using PAA at a future date when they may be upgrading to larger flow rates, as PAA installation and use may be cost competitive compared to installing another UV train. And PAA may also be a good option if variable seasonal or diurnal flow rates or other problems cause exceedances of disinfection permit limits. These non-energy cost drivers may be more important than energy savings when considering PAA implementation